(12) UK Patent Application (19) GB (11) 2 240 785 (13) A

(43) Date of A publication 14.08.1991

(21) Application No 9101342.5

(22) Date of filing 22.01.1991

(30) Priority Data
(31) 02010556 (32) 22.01.1990 (33) JP

(71) Applicant
Daido Metal Company, Ltd

(Incorporated in Japan)

2 Sanage-cho, Kita-Ku, Nagoya, Japan

(72) Inventors
Tadashi Tanaka
Masaaki Sakamoto
Koichi Yamamoto
Tohru Kato

(74) Agent and/or Address for Service
Kilburn and Strode
30 John Street, London, WC1N 2DD, United Kingdom

(51) INT CL[5]
C22C 9/08

(52) UK CL (Edition K)
C7A AB249 AB25Y AB269 AB27X AB271 AB273 AB275 AB277 AB279 AB289 AB309 AB319 AB32X AB32Y AB349 AB35Y AB361 AB363 AB365 AB367 AB369 AB37Y AB377 AB379 AB38X AB399 AB419 AB42Y AB43X AB431 AB433 AB459 AB46Y AB460 AB469 AB470 AB473 AB475 AB477 AB479 AB48X AB481 AB519 AB52Y AB531 AB533 AB535 AB537 AB539 AB549 AB559 AB610 AB613 AB616 AB619 AB62X AB621 AB624 AB627 AB630 AB633 AB66X AB661 AB663 AB665 AB667 AB669 AB67Y AB670 AB675 AB70X AB702 A713

(56) Documents cited
None

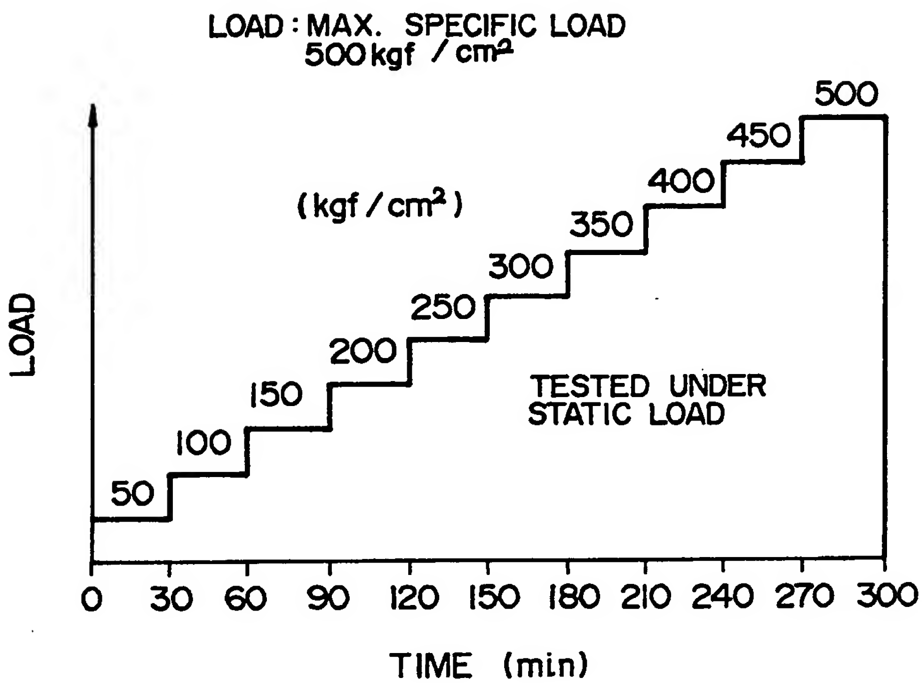
(58) Field of search
UK CL (Edition K) C7A
INT CL[5] C22C

(54) **Bearings**

(57) A copper based alloy, suitable for use in a bearing, is disclosed that can have improved resistance, wear resistance and corrosion resistance. The copper alloy comprises from 1.0 to 3.5 wt% Mn, 0.3 to 1.5 wt% Si, 1 to 25 wt% Zn, 5 to 18 wt% Pb, the balance being substantially Cu (and any incidental impurities). The lead is uniformly distributed throughout the structure of the alloy. The alloy has a microstructure whose matrix is composed of α-phase alone. The alloy can further contain at least one alloy metal from 0.02 to 1.5 wt% Mg or 0.1 to 1.5 wt% Te and one of 0.5 to 3.0 wt% Ni or 0.3 to 3.0 wt% Al.

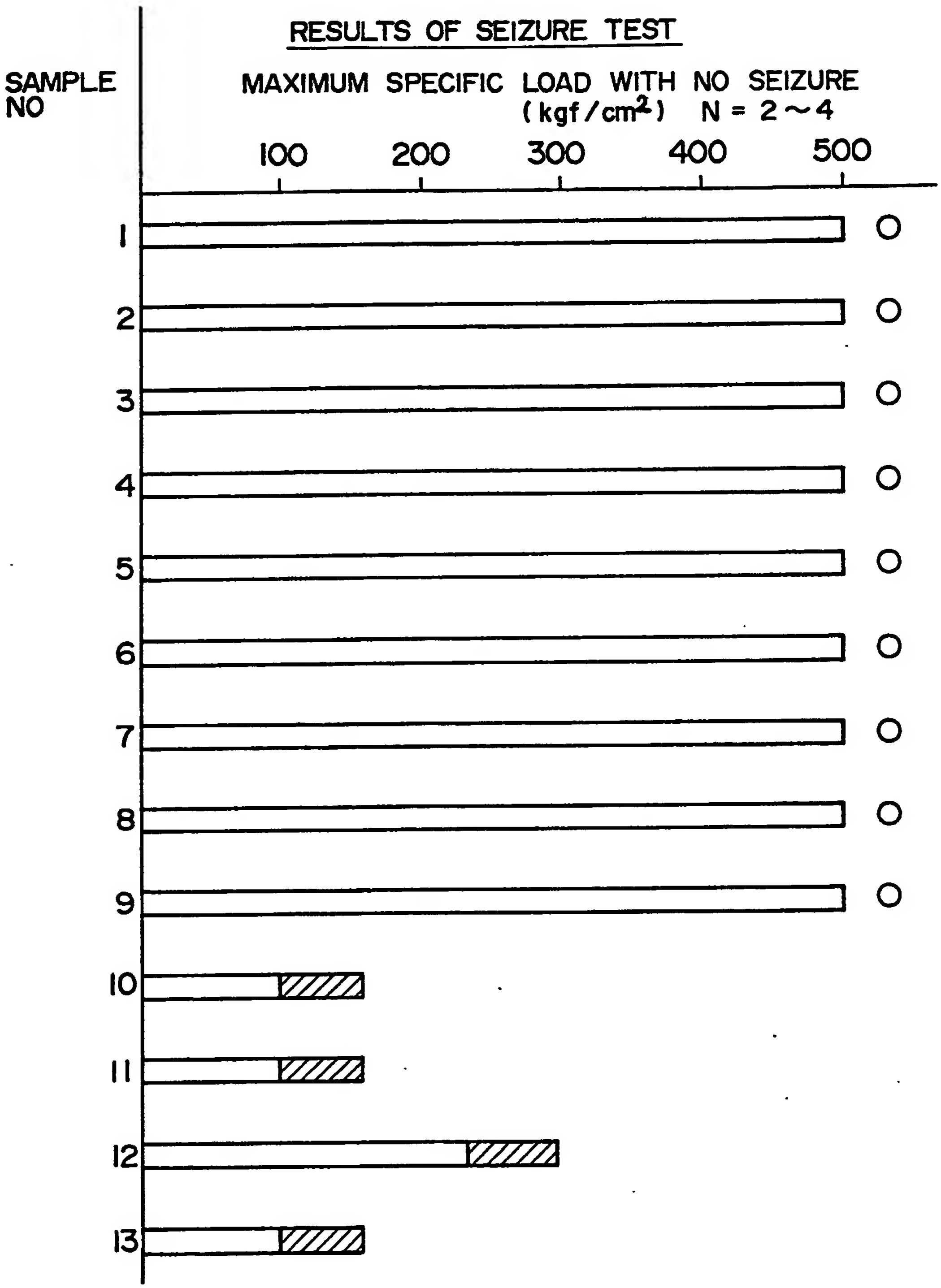
GB 2 240 785 A

FIG. 1



EVALUATION METHOD : SEIZURE IS JUDGED WHEN BEARING BACK TEMPERATURE RISES OVER 200°C, OR FRICTION RESISTANCE RISES OVER 50 kgf·cm^2

F I G. 2



*1: MARKS ○ INDICATE THAT NO SEIZURE WAS OBSERVED
MARKS ▨ INDICATE VARYING RANGES OF TEST RESULTS

*2: SAMPLE NO 1 TO 9 ARE ALLOYS OF INVENTION
SAMPLE NO 10 TO 13 ARE CONVENTIONAL ALLOYS

FIG. 3

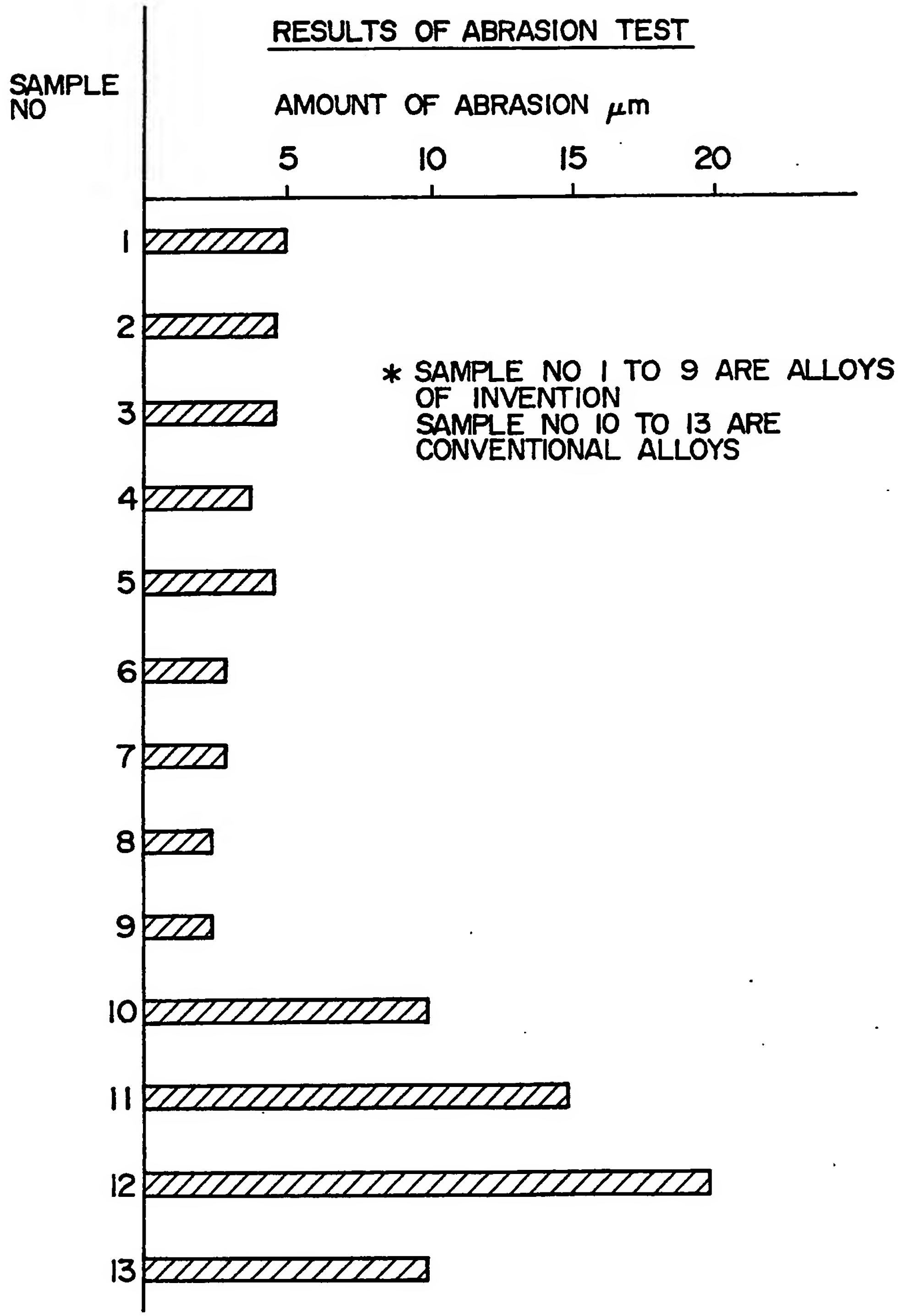

RESULTS OF ABRASION TEST
SAMPLE NO
AMOUNT OF ABRASION μm
5
10
15
20
1
2
3
4
5
6
7
8
9
10
11
12
13
* SAMPLE NO 1 TO 9 ARE ALLOYS OF INVENTION
SAMPLE NO 10 TO 13 ARE CONVENTIONAL ALLOYS

FIG. 4

SAMPLE NO	SURFACE DISCOLORATION	RESULTS OF CORROSION TEST CORROSION AMOUNT (mg/cm3) −1 −2 −3 −4 UPPER BAR : 500HR LOWER BAR : 1000HR
1	LIGHT BLACK	0.02 500HR. TEST 0.03 1000HR. TEST
3	LIGHT BLACK	0.02 500HR. TEST 0.02 1000HR. TEST
5	NO DISCOLORATION	0 500HR. TEST 0.01 1000HR. TEST
9	NO DISCOLORATION	0 500HR. TEST 0.01 1000HR. TEST
10	LIGHT BLACK	0.03 500HR. TEST 0.05 1000HR. TEST
11	BLACK	0.41 500HR. TEST 3.40 1000HR. TEST
12	LIGHT BLACK	0.03 500HR. TEST 0.05 1000HR. TEST

SAMPLE NO 1 TO 9 ARE ALLOYS OF INVENTION
SAMPLE NO 10 TO 13 ARE CONVENTIONAL ALLOYS

BEARINGS

The present invention relates to a copper, e.g. copper based, alloy which may be superior in its resistance to seizure, wear and/or corrosion. The alloy is suitable for use as a material in the manufacture of a sliding member, and particularly sliding members (or bearings) which are used under severe sliding conditions, such as a floating bush bearing of a turbocharger.

In general, the following materials (1), (2) and (3), all of which are alloys, are known as materials for a floating bush bearing of a turbocharger: (1) a free cutting brass (JIS H3250); (2) a lead-bronze (JIS H5115); and (3) a low-friction high-tension brass which is disclosed in JP-B2-53-44135 and JP-B2-56-11735, both earlier patents in the name of the present applicant.

However, the above-mentioned alloy (1) is inferior in its resistance to seizure and wear when used under boundary lubricating conditions, and the alloy (2) can not provide sufficiently high resistance to corrosion when used with deteriorated lubricating oil at high temperatures. The alloy (3) does not satisfactorily inhibit high resistance to seizure because of difficulty in enhancing its lead content due to the fact that this alloy has a micro-structure of which matrix is composed of a mixture of α- and β-phases or β-phase alone.

In recent years, there has been remarkable trend towards supercharged engines, and floating bush bearings which are used in turbochargers that are

attached to internal combustion engines are required to operate under more severe conditions such as ambient temperature, rate of supply of the lubricating oil and degradation of lubrication oil.

Usually a floating bush bearing will be heated to a high temperature, e.g., 400°C or so, due to transfer of heat from a turbine. This means that any sulphur present in a lubricating oil (depending on the nature of the oil and the temperature) tends to react with copper in the bearing metal to form copper sulphide (CuS). This forms a blackened layer, mainly composed of CuS, on the surface of the bearing metal. The blackened layer progressively grows as the bearing is used and then exfoliates from the bearing surface to seriously impair the bearing function of the floating bush bearing.

Furthermore, conventional bearing materials are not able to provide satisfactory seizure resistance in a dry-up condition, i.e., when lubrication with lubricating oil is stopped at a high temperature, such as 300°C or higher. In more detail, a turbocharger, which comprises a gas turbine impeller driven by the energy of exhaust gases at high temperature and pressure, and a compressor driven by the turbine impeller, has to idle, due to its inertia, even after the engine has been stopped which terminates the supply of pressurised lubricating oil (to the turbocharger). Consequently, the turbocharger is obliged to idle a while without the cooling and lubricating effects produced by the lubricating oil. As a result, heat energy which has been accumulated in the turbine

housing, at a high temperature, is transmitted to regions at lower temperatures, thus raising the temperature of the bearing portion. Thus, the bearing should have a high resistance to seizure in dry-up state at high temperatures.

Hitherto, lead-bronze systems containing copper, lead and tin as main components, and free cutting brass containing copper, zinc and lead as main components have been widely used as the material of the floating bush bearings of turbochargers. However, floating bush bearings of lead-bronze system alloy undesirably promote generation of a blackened layer due to reaction between sulphur in the lubricating oil and copper in the bronze. This occurs under dry-up conditions at high temperature of 300°C or so and leads to a rapid wear of the bearing surface. On the other hand, the free cutting brass system alloys, although they may exhibit superior corrosion resistance, exhibit inferior affinity for lubricating oil after the termination of lubrication, thus resulting in a comparatively early seizure or scuffing.

Accordingly, one object of the present invention is to provide a novel copper, e.g. copper-based, alloy suitable for use as a material of a sliding member, which may have improved resistance to wear, seizure and/or corrosion and which can withstand use under severe conditions, such as operation at high sliding speeds and high temperatures in highly-corrosive conditions, as typically encountered by turbocharger bearings.

According to a first aspect of the present invention there is provided a copper alloy comprising from 1.0 to 3.5% manganese (Mn), from 0.3 to 1.5% silicon (Si), from 5 to 18% lead (Pb), from 1 to 25% zinc (Zn), the major component being copper. Thus it will generally be copper that is present in the greatest amount in the copper alloy of the present invention. The copper alloy will usually be in the form of a single piece of metal although it is to be understood that other forms of alloys, including powders, are included. All percentages of components of the copper alloy are in terms of weight, unless otherwise stated.

Usually the balance will be substantially copper, after all of the other components. It will of course be appreciated that there may be some incidental impurities in the copper alloy and therefore the exact balance may not necessarily be copper alone.

It is preferred that the copper alloy is substantially free of tin.

Suitably the lead is uniformly distributed throughout the copper alloy. Alternatively or in addition, the alloy has a structure whose matrix is substantially all α-phase. Thus, the alloy preferably has a micro-structure who matrix is composed of α-phase alone.

The amount of zinc in the copper alloy is preferably from 10 to 25%, and optimally from 13 to 23%.

As far as manganese is concerned, this is preferably

provided at an amount of from 1.5 to 3.0%. for silicon, the preferred amount in the copper alloy ranges from 0.5 to 1.3%. For lead this range is from 6 to 15%.

It will be appreciated that other elements can be included in the copper alloy. These are preferably metals. Particularly preferred alloy metals include tellurium (Te), magnesium (Mg), nickel (Ni) and/or aluminium (Al). Any combination of these four alloy metals may be used in the copper alloy of the present invention. Thus, only one of the four alloy metals may be used. However, if more than one of these four alloy metals are employed, then preferred combinations include tellurium and nickel; tellurium, nickel and aluminium; and tellurium, nickel, aluminium and magnesium (i.e. all four alloy metals). It will therefore be realised that the copper alloy of the present invention preferably additionally comprises tellurium and/or nickel.

If magnesium is provided, then it is suitably present at from 0.02 to 1.5%, such as from 0.8 to 1.2%. As far as tellurium is concerned, if this element is present then it is preferred that it is provided at from 0.1 to 1.5%, such as from 0.8 to 1.2%.

If nickel is present, then it is preferred that this is provided at from 0.5 to 3.0% , such as from 1.0 to 1.5%. Similarly, if aluminium is present then the amount ranges from 0.3 to 3.0%, such as from 1.0 to 1.5%.

A particularly preferred combination of the four alloy metals is to include one of magnesium or tellurium together with one of nickel or aluminium.

The manganese may react will the silicon to form the compound Mn_5Si_3. Thus, although the manganese:silicon ratio may range by as much as from 2:3 to 10:1 (by weight), a preferred weight ratio of Mn:Si is from 1:0.1 to 1:0.5, such as from 1:0.2 to 1:0.4.

The object of the present invention may thus be achieved by any of the following alloys (a) to (d), which are preferred alloys of the present invention.

(a) A copper based alloy suitable for use as a material of a sliding member, that may be superior in seizure resistance, wear resistance and/or corrosion resistance, the alloy comprising from 1.0 to 3.5 wt% of manganese, from 0.3 to 1.5 wt% of silicon, from 10 to 25 wt% of zinc, from 5 to 18 wt% of lead and the balance of the alloy being essentially copper and incidental impurities, the lead being uniformly distributed through the structure of the alloy and the alloy having a micro-structure of which matrix is composed of α-phase alone.

(b) A copper based alloy suitable for use as a material of a sliding member, that may be superior in seizure resistance, wear resistance and/or corrosion resistance, the alloy comprising from 1.0 to 3.5 wt% of manganese, from 0.3 to 1.5 wt% of silicon, from 10 to 25 wt% of zinc, from 5 to 18 wt% of lead, and from 0.02 to 1.5 wt% of magnesium or from 0.1 to 1.5 wt% of

tellurium (or both), the balance of the alloy being essentially copper and incidental impurities, the lead being uniformly distributed through the structure of the alloy and the alloy having a micro-structure of which matrix is composed of α-phase alone.

(c) A copper based alloy suitable for use as a material of a sliding member, that may be superior in seizure resistance, wear resistance and/or corrosion resistance, the alloy comprising from 1.0 to 3.5 wt% of manganese, from 0.3 to 1.5 wt% of silicon, from 10 to 25 wt% of zinc, from 5 to 18 wt% of lead, and from 0.5 to 3.0 wt% of nickel or from 0.3 to 3.0 wt% of aluminium (or both), the balance of the alloy being essentially copper and incidental impurities, the lead being uniformly distributed through the structure of which matrix is composed of α-phase alone.

(d) A copper based alloy suitable for use as a material of a sliding member, that may be superior in seizure resistance, wear resistance and corrosion resistance, the alloy comprising from 1.0 to 3.5 wt% of manganese, from 0.3 to 1.5 wt% of silicon, from 10 to 25 wt% of zinc, from 5 to 18 wt% of lead, and from 0.02 to 1.5 wt% of magnesium or from 0.1 to 1.5 wt% of tellurium (or both), and from 0.5 to 3.0 wt% of nickel or 0.3 to 3.0 wt% of aluminium (or both), the balance of the alloy being essentially copper and incidental impurities, the lead being uniformly distributed through the structure of the alloy and the alloy having a micro-structure of which matrix is composed of α-phase alone.

Reasons for the preferred limitations on the various alloy elements are as follows.

(1) Zinc (Zn): 1 to 25 wt%

Zinc may provide strength and wear resistance, as well as corrosion resistance to the lubricating oil. The preferred amount of this element depends on zinc equivalents of other elements but the amount of zinc is preferably not less than 10 wt% because these properties may not be appreciable when the zinc content is below 10 wt%. The amount of lead (Pb), which conventionally has been added in order to improve seizure resistance, can be undesirably limited if the structure has a mixed phase of α and ß. Therefore, as a rule, the alloy of the present invention is suitably a single-phase structure of α-phase. In order to ensure a micro-structure of α-phase alone and allow a minimum amount, e.g., 5 wt%, of lead in the α-phase, the maximum content of zinc is preferably 25% wt.

(2) Manganese (Mn): 1.0 to 3.5 wt%

Manganese can react with silicon (Si) so as to form the intermetallic compound Mn_5Si_3 which may have superior sliding characteristics, and may thus contribute to improvements in wear resistance and seizure resistance, while preventing any plastic flow of the matrix in the event of a metal-to-metal contact. In order to obtain an appreciable effect, the manganese is suitably present at at least 1.0 wt%. Any manganese content exceeding 3.5 wt%, on the other hand, may cause a saturation of the effect and, more importantly, undesirably embrittle the alloy.

(3) Silicon (Si): 0.3 to 1.5 wt%

As discussed, silicon reacts with manganese to form the intermetallic compound Mn_5Si_3 which can contribute to any improvement in the wear resistance and seizure resistance. The content of silicon is usually determined in accordance with the desired amount of Mn_5Si_3 to be obtained. All the silicon can be converted into this compound when the ratio of manganese to silicon is 1:0.3 in terms of weight. Thus, preferred minimum silicon content should be 0.3 wt%. Addition of silicon in excess of the upper limit value of 1.5 wt% may result in an excessive crystallisation of free silicon, causing embrittlement of the alloy.

(4) Lead (Pb): 5 to 18 wt%

Lead usually has a self-lubricating property and can easily be made molten by frictional heat so spreading over the sliding surface to form a thin film of several microns thick. This can remarkably improve seizure resistance and may also attain a good machining property. In order to form the thin film of lead of several microns thick, the lead content is suitably at least 5 wt%. An increase in the lead content, on the other hand, may cause a reduction in the strength of the alloy, so that the maximum lead content is preferably set at 18 wt%. The lead content, therefore, is suitably in the range of from 5 to 18 wt%.

(5) Magnesium (Mg): (optionally) 0.02 to 1.5 wt%

Magnesium can be effective in uniformly dispersing lead and also in strengthening the matrix. These effects may not be appreciable if the magnesium content

falls below 0.02 wt%. Addition of magnesium in excess of 1.5 wt%, may on the other hand, cause an excessive crystallisation of an intermetallic compound of magnesium and lead, thus impairing the lubricating effect produced by the lead. For these reasons, the content of magnesium is preferably limited to range from 0.02 wt% to 1.5 wt%.

(6) Tellurium (Te): (optionally) 0.1 to 1.5 wt%

The presence of a small amount of tellurium may promote uniform dispersion of lead and improve toughness and seizure resistance, as well as corrosion resistance, of the alloy. These effects, however, may not be appreciable of the tellurium content is below 0.1 wt%. On the other hand, addition of tellurium in excess of 1.5 wt% may cause a substantial saturation of the effect while raising the cost uneconomically. The amount of addition of tellurium, therefore, is suitably provided to range from 0.1 to 1.5 wt%.

(7) Nickel (Ni): (optionally) 0.5 to 3.0 wt%

Nickel may strengthen the matrix so as to improve the strength of the alloy while enhancing wear resistance. Nickel may also raise the recrystallisation temperature so as to prevent coarsening of the crystal grains during hot plastic working. These effects, however, may not be noticeable when the nickel content is below 0.5 wt%. On the other hand, addition of nickel in excess of 3 wt% may, in some circumstances, seriously impair fatigue strength and impact resistance of the alloy. For these reasons, the nickel content preferably ranges from 0.5 to 3.0 wt%.

(8) Aluminium (Al): (optionally) 0.3 to 3.0 wt%

Aluminium may also contribute to strenghtening of the matrix. This effect, however, may not be appreciable if the aluminium content is below 0.3 wt%. On the other hand, an aluminium content exceeding 0.3 wt% may undesirably cause embrittlement and coarsening of the crystal grains. For these reasons, the aluminium content preferably ranges from 0.3 to 3.0 wt%.

A second aspect of the present invention relates to a process for the preparation of a copper alloy comprising from 1.0 to 3.5% manganese, from 0.3 to 1.5% silicon, from 5 to 18% lead, from 1 to 25% zinc, the major component being copper, the process comprising admixing the components.

Here the term "components" refers not only to the manganese, silicon, lead, zinc and copper, but any other ingredients (whether other elements, such as alloy metals, or compounds). It will be appreciated that the process includes not only the process of mixing all of the components simultaneously, but also includes a process whereby two or more of the components are admixed before further mixing with any or all of the remaining components. Processes for making the copper alloys of the present invention will be known by those skilled in the art.

Preferred features and characteristics of the second aspect are as for the first aspect *mutatis mutandis*.

A third aspect of the present invention relates to a sliding member comprising a copper alloy of the first aspect. The sliding member will usually be a bearing. Often the sliding member will be present in a supercharger, such as a turbocharger.

Thus, according to a fourth aspect of the present invention there is provided a supercharger which is provided with a sliding member of the third aspect. The supercharger will generally be a turbocharger.

Preferred features and characteristics of the third and fourth aspects are as for the first and second aspects *mutatis mutandis*.

Several examples of the alloy of the present invention, which are provided for means of illustration, will now be described with reference to the accompanying drawings, in which:

Figure 1 is a graph of load against time illustrating the procedure of a seizure resistance test used to test prior art alloys and alloys of the present invention (also referenced in Table 4);

Figure 2 is a bar chart illustrating the results of the seizure resistance test on prior art alloys and alloys of the present invention;

Figure 3 is a second bar chart showing the results of a wear resistance test on prior art alloys and alloys of the present invention; and

Figure 4 shows the results of a corrosion resistance test on prior art alloys and alloys of the present invention.

The invention will now be describes by way of example, with reference to the accompanying Examples which are provided for means of illustration and are not to be construed as being limiting.

Examples 1 to 9 (Alloys of the Present Invention)

Alloys of compositions nos. 1 to 9 shown in Table 1 were prepared by continuous casting process and were formed into bars of 35 mm diameter through extrusion and drawings. (Alloy no. 9 contained 18% zinc). The bars were suitably worked to provide test pieces for a seizure test, abrasion test and a corrosion test.

The conditions of the tests conducted on these test pieces are shown in Tables 2 to 4 and Figure 1. The results of the seizure test and the abrasion test are shown in Figure 2, Table 5 and in Figure 3 respectively. Representative data of the results of the corrosion test is shown in Figure 4.

Comparative Examples 10 to 13 (Conventional Alloy)

Conventional alloys of compositions nos. 10 to 13, as shown in Table 1, were formed into bars of 35 mm diameter through continuous casting, extrusion and drawing. These bars were subjected to the same tests as those for the test pieces of Examples 1 to 9. The conditions of these tests are shown in Tables 2 to 4

and Figure 1, while the test results are shown in Figures 2 to 4 and Table 5.

Although the tests were conducted on the alloy bars which were produced through continuous casting, it is to be understood that the same advantages are obtained with test pieces of alloys formed by a different casting method, such as stationary casting.

Table 1

Class	Sample No.	Composition (wt%)											Mechanical Property		
		Cu	Zn	Pb	Mn	Si	Te	Mg	Al	Ni	Sn	Fe	Tensile Strength (Kgf/mm²)	Elongation (%)	Hardness (Hv10)
Alloy of The Present Invention	1	Bal.	18	6	2.5	1.0							28.3	7.4	104
	2	Bal.	20	15	2.0	0.7							27.0	7.0	105
	3	Bal.	15	6	3.0	1.3	1.0						29.0	9.0	110
	4	Bal.	23	13	2.0	1.0		1.0					29.5	10.0	106
	5	Bal.	15	6	1.5	0.5				1.0			32.0	9.0	115
	6	Bal.	18	15	2.0	1.0			1.0				31.5	8.0	110
	7	Bal.	13	13	2.0	0.8	1.0			1.0			30.0	9.0	112
	8	Bal.	23	15	2.0	0.8	1.0		1.5	1.0			34.0	10.0	110
	9	Bal.	1.8	6	1.5	0.5	1.0	1.0	1.0	1.5			37.0	11.0	125
Conventional Alloy	10	59	Bal.	3									41.3	32.2	128
	11	Bal.		15							8		29.3	12.6	87
	12	58	Bal.		1.5				1.0			0.5	61.0	27.0	140
	13	Bal.	34.1	4	3.0	1.2	0.4		1.3				55.0	25.0	151

Table 2

Abrasion test		
Testing Condition	Value	Unit
1. Testing Machine	Bush Tester	
2. Bush Size	Ø20 x Ø23 x L20	mm
3. Rotation Speed	3,000	rpm
4. Circumferential Speed	3.14	m/s
5. Surface Pressure (projected)	10	kgf/cm^2
6. Clearance (Diameter)	0.08~0.10	mm
7. Lubricant	10	OC/min
8. Temperature	150	°C
9. Shaft Material	S55C	-
Roughness	1.0	Rmax μm
Hardness	500~600.	Hv 10kg
10. Time	100	hour

Table 3

Corrosion test	
Testing Condition	
Oil	Immersing in Turbo Lubricating Oil (equivalent to 15 W-40).
Test Temperature	130°C
Test Time	500 Hr, 1000 Hr

Table 4

Seizure test		
Testing Condition	Value	Unit
1. Testing Machine	Suzuki-type Tester	
2. Bearing Size	Ø25 x Ø21.7 OD x ID	mm
3. Rotation Speed	1055	rpm
4. Circumferential Speed	1.29	m/s
5. Lubricant	SAE 30	-
6. Lubricating Method	Oil Bath	-
7. Lubricant Temperature	Room Temperature	°C (at starting time)
8. Shaft Material	S55C	
Roughness	0.3	Rmax μm
Hardness	500~600	Hv 10kg

Table 5

Class	Sample No.	Results of Test on Actual Turbocharger (Oil ON-OFF Test at Predetermined Speed)
Alloy of The Present Invention	1	3000 cycle OK
	2	"
	3	"
	4	"
	5	"
	6	"
	7	"
	8	"
	9	"
Conventional Alloy	10	Seizure occurred in 2nd cycle
	11	Seizure occurred in 5th cycle
	12	Seizure occurred in 10th cycle
	13	Seizure occurred in 10th cycle

Evaluation of Test results

(1) From the comparison of the results of the seizure test whose conditions are shown in Figure 2, it will be seen that the alloys of the present invention can be used without risk of seizure up to the maximum load of 500 kgf/cm^2, which should be contrasted to the conventional prior art free cutting brass (No. 10) and high-strength brass (nos. 12 and 13).

(2) The alloys of the present invention did not show any seizure in the seizure test over a specific number of revolutions in an actual machine which incorporated a bearing made of the alloy to be tested. The supply of lubricating oil to the machine was turned on and off, as shown in Table 5. The alloys of the present invention exhibited superior performance, as a sliding material, over prior art alloys, thus giving a satisfactory and acceptable result when used as the material of a floating bush bearing.

(3) As will be seen from Figure 3, which shows the result of the abrasion test, the alloys in accordance with the present invention showed less wear than conventional prior art alloys, demonstrating superior wear resistance. The abrasion test was conducted in a wet process using a lubricating oil, while employing a quench-hardened bearing made of JIS S55C as the mating (or opposed) sliding member.

(4) The alloys in accordance with the present invention were also superior in corrosion resistance

than conventional prior art alloys as will be seen from the results shown in Figure 4.

Thus, the copper alloys of the present invention may be superior in seizure resistance, wear resistance and/or corrosion resistance compared with conventional alloys. These characteristics can offer remarkable advantages, particularly when the alloy of the present invention is used as a material in a sliding member. Such sliding members are often required to have an improved performance and life, for example in turbochargers.

CLAIMS

1. A copper alloy comprising from 1.0 to 3.5% manganese, from 0.3 to 1.5% silicon, from 5 to 18% lead, from 1 to 25% zinc, the major component being copper.

2. An alloy as claimed in claim 1 when the balance is substantially copper.

3. An alloy as claimed in claim 1 or 2 wherein the zinc is present at from 10 to 15%.

4. An alloy as claimed in any of claims 1 to 3 wherein the lead is uniformly distributed in the alloy.

5. An alloy as claimed in any of claims 1 to 4 which has a micro-structure whose matrix is substantially only α-phase.

6. An alloy as claimed in any of claims 1 to 5 wherein the manganese is at from 1.5 to 3.0%.

7. An alloy as claimed in any of claims 1 to 6 wherein the silicon is present at from 0.5 to 1.3 %.

8. An alloy as claimed in any of claims 1 to 7 wherein the zinc is present at from 13 to 23%.

9. An alloy as claimed in any of claims 1 to 8 wherein the lead is present at from 6 to 15%.

10. An alloy as claimed in any of claims 1 to 9

additionally comprising one of the four alloy metals tellurium, magnesium, nickel and/or aluminium.

11. An alloy as claimed in claim 10 which additionally comprises only one of tellurium, magnesium, nickel or aluminium.

12. An alloy as claimed in claim 10 additionally comprising one of magnesium or tellurium together with one of nickel or aluminium.

13. An alloy as claimed in any of claims 10 to 12 additionally comprising tellurium and/or nickel.

14. An alloy as claimed in any of claims 10 to 13 additionally comprising tellurium and nickel, tellurium nickel and aluminium, or tellurium nickel aluminium and magnesium.

15. An alloy as claimed in any of claims 10 to 14 wherein the magnesium is present at from 0.02 to 1.5%.

16. An alloy as claimed in any of claims 10 to 15 wherein the tellurium is present at from 0.1 to 1.5%.

17. An alloy as claimed in any of claims 1 to 15 wherein the nickel is present at from 0.5 to 3.0%.

18. An alloy as claimed in any of claims 1 to 15 wherein the aluminium is present at from 0.3 to 3.0%.

19. An alloy as claimed in any of claims 1 to 18 wherein the weight ratio of manganese:silicon is from

1:0.1 to 1:0.5.

20. An alloy as claimed in any of claims 1 to 19 wherein the ratio of manganese:silicon is from 1:0.2 to 1:0.4.

21. A process for the preparation of a copper alloy comprising from 1.0 to 3.5% manganese, from 0.3 to 1.5% silicon, from 5 to 18% lead, from 1 to 15% zinc, the major component being copper, the process comprising admixing the components.

22. A process as claimed in claim 21 for preparing a copper alloy as claimed in any of claims 1 to 20.

23. A sliding member comprising a copper alloy as claimed in any of claims 1 to 20.

24. A sliding member as claimed in claim 23 which is a bearing.

25. A sliding member as claimed in claim 23 or 24 which is a supercharger bearing.

26. A sliding member as claimed in any of claims 23 to 25 which is a turbocharger bearing.

27. A supercharger provided with a sliding member as claimed in any of claims 23 to 26.

28. A supercharger as claimed in claim 27 which is a turbocharger.

29. A copper alloy substantially as herein described with reference to the Examples, but without reference to the Comparative Examples.

30. A bearing substantially as herein described with reference to the Examples, but without reference to the Comparative Examples.

Published 1991 at The Patent Office, State House, 66/71 High Holborn, London WC1R 4TP. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.

PAT-NO: GB002240785A

DOCUMENT-IDENTIFIER: GB 2240785 A

TITLE: Bearings

PUBN-DATE: August 14, 1991

INVENTOR-INFORMATION:

NAME	COUNTRY
TANAKA, TADASHI	N/A
SAKAMOTO, MASAAKI	N/A
YAMAMOTO, KOICHI	N/A
KATO, TOHRU	N/A

ASSIGNEE-INFORMATION:

NAME	COUNTRY
DAIDO METAL CO	JP

APPL-NO: GB09101342

APPL-DATE: January 22, 1991

PRIORITY-DATA: JP01055690A (January 22, 1990)

INT-CL (IPC): C22C009/08

EUR-CL (EPC): C22C009/04 ; F16C033/12

ABSTRACT:

CHG DATE=19940730 STATUS=O> A copper based alloy, suitable for use in a
bearing, is disclosed that can have improved resistance, wear resistance and
corrosion resistance. The copper alloy comprises from 1.0 to 3.5 wt% Mn, 0.3
to 1.5 wt% Si, 1 to 25 wt% Zn, 5 to 18 wt% Pb, the balance being substantially
Cu (and any incidental impurities). The lead is uniformly distributed
throughout the structure of the alloy. The alloy has a microstructure whose
matrix is composed of alpha -phase alone. The alloy can further contain at
least one alloy metal from 0.02 to 1.5 wt% Mg or 0.1 to 1.5 wt% To and one of
0.5 to 3.0 wt% Ni or 0.3 to 3.0 wt% Al.

DERWENT-ACC-NO: 2002-715372
DERWENT-WEEK: 200280

TITLE: Composite sliding material for bearing used in automobiles, machines,
comprises sintered copper alloy layer comprising preset amounts of tin,
bismuth, solid lubricant, optionally e.g. iron, bonded to steel plate

INVENTOR: INOUE, E; KURIMOTO, S ; SAKAI, K ; SHIBAYAMA, T ; YAMAMOTO, K

PATENT-ASSIGNEE: DAIDO METAL CO LTD[DAME], DAIDO METAL KOGYO KK[DAME]

PRIORITY-DATA: 2001JP-0084916 (March 23, 2001)

PATENT-FAMILY:

PUB-NO	PUB-DATE	LANGUAGE	PAGES	MAIN-IPC
JP 2002285262	October 3, 2002	N/A	006	C22C 009/02

A October 9, 2002 N/A 023
F16C 033/12
GB 2374086 A

APPLICATION-DATA:
PUB-NO APPL-DESCRIPTOR APPL-NO
APPL-DATE
JP2002285262A N/A 2001JP-0084916
March 23, 2001
GB 2374086A N/A 2002GB-0005118
March 5, 2002

INT-CL (IPC): B22F007/00; B22F007/04 ; C10M103/00 ; C10M103/02 ;
C10M103/06 ; C10M125/04 ; C10M169/04 ; C10N010:02 ; C10N010:04 ;
C10N010:06 ; C10N010:08 ; C10N010:10 ; C10N010:12 ; C10N010:14 ;
C10N010:16 ; C10N030:06 ; C10N030:18 ; C10N040:02 ; C10N050:08 ;
C22C001/10 ; C22C009/00 ; C22C009/02 ; F16C033/10 ; F16C033/12

ABSTRACTED-PUB-NO: GB 2374086A

BASIC-ABSTRACT: NOVELTY - Composite sliding material comprises a sintered copper alloy layer bonded to a steel plate. The copper alloy

essentially
comprises (in mass%) tin (1.5-15), bismuth (1.5-15), solid lubricant (1.5-20 volume%), optionally iron, aluminum, zinc, manganese, cobalt, nickel, and/or silicon (not more than 40), balance copper and impurities. The volume ratio of bismuth to the solid lubricant is 0.5-20.

USE - For bearing materials used in automobiles, agricultural machines, industrial machines.

ADVANTAGE - Tin and phosphorus strengthen the copper matrix of the copper alloy. Bismuth liquefies during sintering and improves sintering property of the copper alloy including anti-seizure property and wear resistance of the copper alloy in oil lubricating and non-lubricating regions. Bismuth together with the solid lubricant improve machinability of the sliding material. The copper plating layer improves bonding strength between the sintered copper alloy layer and the steel plate. The copper system composite sliding material

without lead, having excellent sliding property equal to or superior to those of lead-bronze system sintered copper alloy and excellent mechanical strength, is provided.

DESCRIPTION OF DRAWING(S) - The figure shows the schematic sectional view of the sintered copper alloy metal structure.

CHOSEN-DRAWING: Dwg.1/2

TITLE-TERMS:
COMPOSITE SLIDE MATERIAL BEARING AUTOMOBILE MACHINE COMPRISE SINTER COPPER ALLOY LAYER COMPRISE PRESET AMOUNT TIN BISMUTH SOLID LUBRICATE OPTION IRON BOND STEEL PLATE

DERWENT-CLASS: H07 M26 Q62

CPI-CODES: H07-D; M26-B03; M26-B03B; M26-B03J; M26-B03M; M26-B03N; M26-B03Z;

SECONDARY-ACC-NO:
CPI Secondary Accession Numbers: C2002-203055
Non-CPI Secondary Accession Numbers: N2002-564315